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(54) [Title of the Invention] INK JET PRINTER AND FORMATION OF FLUORESCENT SCREEN OF CATHODE RAY TUBE USING THE SAME

(57) [Abstract]

[Object] To change an opening diameter of an orifice in order to prevent clogging of an ink jet nozzle, facilitate the maintenance, prevent unnecessary dripping of ink, consistently obtain an optimum recording dot diameter, and to facilitate a step of selectively forming an intermediate film on phosphor layers when forming a panel inner surface of a cathode ray tube in an ink jet printer.

[Solving Means] In the ink jet printer 10 to discharge ink Ia from an orifice according to an image signal and depict an image on a material to be recorded, at least a part of an orifice forming member comprises a composite member 21 integrating a hard material 19b with a

piezoelectric element 20. In a method for forming a fluorescent screen of a cathode ray tube, an intermediate film is formed by selectively discharging an intermediate film forming coating material on phosphor layers 2R, 2G and 2B by using the ink jet printer 10.

[Claims]

[Claim 1] An ink jet printer for discharging ink from an orifice according to image signals, and performing depiction on a material to be recorded, wherein at least a part of an orifice forming member comprises composite members integrating a hard material with a piezoelectric element.

[Claim 2] A method for forming a fluorescent screen of a cathode ray tube by forming a light absorbing layer and phosphor layers on a panel surface of the cathode ray tube, forming an intermediate film on the phosphor layers, forming a metal back layer on the intermediate film, and thermally decomposing and removing the intermediate film, wherein the intermediate film is formed by discharging an intermediate film forming coating material from the orifice of the printer by using the ink jet printer according to Claim 1.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention] The present invention relates to an ink jet printer capable of changing the opening diameter of an orifice, and a method for forming a fluorescent screen of a cathode ray tube using the ink jet printer.

[0002]

[Description of the Related Arts] Generally as shown in Fig. 4, phosphor layers 2 of red, green and blue colors are

formed on a panel 1 in a stripe shape or a dot shape on panel inner surface of a cathode ray tube used for a color picture tube, a light absorbing layer 3 formed of carbon black or the like is formed between the respective phosphor layers 2, and a metal back layer 4 is formed thereon.

[0003] Here, the metal back layer 4 is provided to improve the brightness of a screen by reflecting the component directed toward a back side of the fluorescence emitted by exciting the phosphor layers 2 by electron beams forward. An aluminum thin film of high transmittance and high reflectance of electron beams is formed for the metal back layer 4.

[0004] It is thus important that the metal back layer 4 of such functions is formed on the phosphor layers 2 with high smoothness. Therefore, in a method for forming a panel inner surface, for example, as shown in Fig. 5, a stripe-shaped light absorbing layer 3 is formed on an inner surface of the panel 1 (Fig. 5a), phosphor layers 2R, 2G and 2B are formed between spaces separated by the respective light absorbing layers 3 (Fig. 5b), an intermediate film forming coating material is coated to smoothen the surfaces thereof without directly forming the metal back layer on the light absorbing layer 3 and the respective phosphor layers 2R, 2G and 2B, and the intermediate film 5 is formed (Fig. 5c), and the metal back layer 4 is then formed on the intermediate

film 5 (Fig. 5d). Next, the intermediate film 5 is thermally decomposed and removed through the baking so that the metal back layer 4 is formed on the light absorbing layer 3 and the phosphor layers 2R, 2G and 2B of the respective colors (Fig. 5e).

[0005] In this case, in the method for forming the light absorbing layer 3 and the respective phosphor layers 2R, 2G and 2B in a stripe shape, a so-called slurry method including a step of fully coating a coating material for forming the light absorbing layer and a coating material for forming the phosphor layers on the entire surface is used. For example, the photosensitive resin layer is formed on a panel before forming the light absorbing layer to be formed in a stripe shape, the photosensitive resin layer is exposed and developed to perform the patterning, the light absorbing layer is formed thereon, and lifted off to perform the patterning of the light absorbing layer. Further, photosensitivity is given to the phosphor layers themselves to be formed in a stripe shape, a coating material for forming the phosphor layers is coated on a panel with the light absorbing layer formed thereon, exposed, and developed to perform the patterning (Japanese Patent Laid-Open No. 61-68827, or the like).

[0006]

[Problems to be Solved by the Invention] However, according

to the above-described panel inner surface forming method, the following problems have occurred in recent years as high resolution is requested for the cathode ray tube, and the pitches of the stripes of the respective phosphor layers 2R, 2G and 2B is reduced. In other words, when the intermediate film forming coating material of sufficient quantity to smoothen surfaces of the respective phosphor layers 2R, 2G and 2B is coated, the quantity of the intermediate film to cover the light absorbing layer 3 is increased as a result, a large amount of decomposition gas is generated from the intermediate film 5 during the subsequent baking of the intermediate film 5, the metal back layer 4 is pushed up thereby, and the metal back layer 4 is raised or peeled off. To cope with this problem, if the coating quantity of the intermediate film forming coating material is reduced to reduce the quantity of decomposition gas from the intermediate film 5, the surfaces of the respective phosphor layers 2R, 2G and 2B cannot be fully smoothened, and the reflectance of the metal back layer 4 is degraded.

[0007] Thus, a trial has been performed in that the intermediate film 5 is selectively formed on the respective phosphor layers 2R, 2G and 2B by providing the photosensitivity to the intermediate film forming coating material itself, coating the intermediate film forming coating material, and performing exposure and development

thereof. However, in this method, problems occur in that an exposure step and a development step requiring attachment/detachment of an aperture grille and a shadow mask are required, and the working steps are complicated.

[0008] On the other hand, an ink jet printer to perform depiction by discharging ink from an orifice has been known as a non-contact type printer. It is thus devised that the intermediate film forming coating material is selectively discharged on the respective phosphor layers 2R, 2G and 2B from the orifice by using the ink jet printer in order to selectively form the intermediate film 5 on the respective phosphor layers 2R, 2G and 2B.

[0009] Here, in order to finely depict letters and images by the ink jet printer, it is generally required to reduce the recording dot diameter. Factors to influence the recording dot diameter include the physical properties of ink such as the viscosity and the surface tension of ink, the physical properties of the material to be recorded, and the opening diameter of the orifice. Among them, the opening diameter of the orifice is an important factor. For example, generally speaking, the particle size of the ink becomes about 1.9 times the orifice diameter when the ink column passing through the orifice is turned into particles in air, about 2.9 times when the ink is adhered to the material to be recorded, and the recording dot diameter

becomes finally about 5.5 times the opening diameter of the orifice. Thus, in order to reduce the recording dot diameter to obtain fine images, the opening diameter of the orifice must be reduced. In the conventional ink jet printers, the orifice forming member is formed of hard ceramic and a hole of a very small diameter is generally opened in the hard ceramic as a method for obtaining an orifice of the small opening diameter.

[0010] However, in the conventional orifice forming members, a hole is simply opened in hard ceramic, the following problems occur, and the conventional printers cannot be used to form the intermediate film of the fluorescent screen of the cathode ray tube in practical use.

[0011] Firstly, since the opening diameter of the orifice is very small, the orifice is easily clogged, and the maintenance of the orifice when it is clogged is also difficult. In particular, when the intermediate film forming coating material containing resin particles, inorganic pigments or the like is discharged from the orifice, a problem of such clogging is remarkable.

[0012] Secondly, since the pigments contained in ink are collided with the orifice forming member when ink is discharged from the orifice, the orifice forming member is gradually worn, the opening shape of the orifice is deformed, and it is difficult to obtain the desired recording dot

diameter. This problem in that the orifice forming member is worn will be serious when the intermediate film forming coating material containing inorganic pigments or the like is discharged from the orifice.

[0013] As described above, in order to consistently keep the predetermined recording dot diameter when the opening diameter of the orifice is fluctuated, the viscosity, the surface tension or the like of ink must be adjusted according to the degree of fluctuation, and such adjustment of ink is troublesome.

[0014] Thirdly, since the orifice tip opening part is constantly opened, ink adhered to a periphery of the orifice tip opening part is dripped on the material to be recorded even when the discharge of ink is stopped, and so-called dripping of ink occurs. Therefore, the ink jet printer cannot be used if a predetermined pattern must be depicted correctly.

[0015] Fourthly, since the opening diameter of the orifice cannot be changed to a desired size, the recording dot diameter cannot be changed to a desired size either. Thus, when depiction is performed on the intermediate film in the stripe shape of the line width larger than the opening diameter of the orifice, there occur inconveniences in that the stripe of the line width cannot be depicted in one scanning of the orifice, a pattern of the line width of the

predetermined recording dot diameter to be determined according to the opening diameter of the orifice must be repeatedly depicted, or an orifice of different opening diameter must be re-fitted.

[0016] The present invention is achieved to solve the above-described problems with the conventional technology. An object of the present invention is to form an intermediate film of high productivity with a simple operation by using an ink jet printer when selectively forming the intermediate film 5 on the respective phosphor layers 2R, 2G and 2B so as to prevent the metal back layer 4 from being raised or peeled off even when the intermediate film 5 of sufficient thickness is formed on the phosphor layers 2R, 2G and 2B so that the reflectance of the metal back layer 4 is enhanced when forming the panel inner surface of the cathode ray tube, and to obtain an ink jet printer which is utilized in forming such an intermediate film.

[0017]

[Means for Solving the Problems] The Inventors found that the opening diameter of the orifice can be changed when the composite members integrating the hard material with the piezoelectric element are used for the orifice forming member of the ink jet printer, and the ink jet printer is effective for the above object, and completed the present

invention.

[0018] In other words, the present invention provides an ink jet printer characterized in that at least a part of the orifice forming member is formed of the composite members integrating the hard material with the piezoelectric element in the ink jet printer which discharges ink from the orifice according to the image signals, and performs depiction on the material to be recorded.

[0019] Further, the present invention provides the method for forming the fluorescent screen of the cathode ray tube characterized in that the intermediate film is formed by discharging the intermediate film forming coating material from the orifice of the printer by using the above-described ink jet printer in the method for forming the fluorescent screen of the cathode ray tube in which the light absorbing layer and the phosphor layers are formed on the panel surface of the cathode ray tube, the intermediate film is formed on the phosphor layers, the metal back layer is formed on the intermediate film, and then, the intermediate film is thermally decomposed and removed.

[0020] The present invention will be described below with reference to the drawings.

[0021] Fig. 1 is an overall view of an embodiment of an ink jet printer of the present invention, and Fig. 2 is a schematic representation of an ink jet nozzle of a recording

head unit (Fig. 2(a) is a sectional representation of the nozzle in the ink discharging direction, and Fig. 2(b) is a representation of the nozzle when viewed from an opening part side of the nozzle).

[0022] The ink jet printer 10 in Fig. 1 has a robot 12 to be moved in X-axis, Y-axis, Z-axis and R-axis directions on a base table 11. An ink jet nozzle 15 is fitted to the robot 12 via an ink discharging nozzle fitting frame 13 and an ink discharging nozzle fitting support part 14.

[0023] As shown in Fig. 2, this ink jet nozzle 15 has a nozzle base body 16 and a piezoelectric element 17 for manufacturing ink particles, and a high frequency power source 18 for manufacturing ink particles is connected to the piezoelectric element 17 for manufacturing ink particles. A hard member 19a formed of a hard material such as hard ceramic of excellent wear resistance is provided on a tip part of the nozzle base body 16. The piezoelectric element 17 for manufacturing ink particles and the high frequency power source 18 for manufacturing ink particles may be similar to those used in a conventional ink jet nozzle. Further, the robot 12 may also be a conventional robot so long as an arm of the robot can be moved to arbitrary X, Y and Z positions.

[0024] The ink jet nozzle 15 has a pair of composite members 21 integrated with the hard member 19b formed of the

hard material such as hard ceramic of excellent wear resistance and the piezoelectric element 20 for adjusting the opening part in a facing manner each other at a tip part of the orifice, in other words, at the nozzle tip opening part 15a of the ink jet nozzle, which is characteristic with the ink jet printer of the present invention. A lamination longitudinal effect type piezoelectric element using PZ ceramic is preferably provided for the piezoelectric element 20 for adjusting the opening part. A power source 22 for adjusting an opening part is connected to the piezoelectric element 20 for adjusting the opening part, and a pulse voltage generation type stabilized power supply of excellent responsiveness is preferably provided for the power source 22 for adjusting the opening part.

[0025] In this ink jet printer 10, a material 23 to be recorded is placed on the base table 11.

[0026] When printing is performed on the material 23 to be recorded, the robot 12 is moved at a predetermined speed on a predetermined position on the material 23 to be recorded so as to depict a predetermined ink pattern on the material 23 to be recorded, and the ink jet nozzle 15 discharges ink.

[0027] In this case, in the ink jet nozzle 15, the high frequency power source 18 for manufacturing ink particles applies the voltage to the piezoelectric element 17 for manufacturing ink particles based on printing output signals

to operate the piezoelectric element 17 for manufacturing ink particles, the ink Ia is sufficiently pressurized, and discharged from the nozzle tip opening part 15a under the high frequency vibration. The ink is turned into ink column Ib, and rapidly grows into ink particles Ic by the vibration applied thereto by the piezoelectric element 17 for manufacturing ink particles, and the ink particles adhere to the material 23 to be recorded.

[0028] Here, the nozzle tip opening part 15a can be opened/closed by apply the DC or pulse voltage to the piezoelectric element 20 for adjusting the opening part by the power source 22 for adjusting the opening part, and further, the size of the nozzle tip opening part 15a can be finely adjusted. Therefore, a desired recording dot diameter can be obtained by controlling the voltage applied to the piezoelectric element 20 for adjusting the opening part according to the wear state of the hard members 19a and 19b to form the nozzle tip opening part 15a, the physical properties of the ink Ia, or the like, and fine images can be depicted. In addition, information on the desired recording dot diameter is also input in the high frequency power source 18 for manufacturing ink particles to control the piezoelectric element 17 for manufacturing ink particles in addition to the image information to be printed. Fine images can also be depicted more consistently by controlling

the diameter of the nozzle tip opening part 15a. Further, when the ink Ia is not discharged from the ink jet nozzle 15, the nozzle tip opening part 15a is kept closed, and unnecessary dripping of ink can be prevented. In addition, during the maintenance of the ink jet nozzle 15, the nozzle tip opening part 15a can be largely opened, and the maintenance operation is facilitated thereby.

[0029] As described above, the ink jet printer 10 shown in Figs. 1 and 2 is described. However, the printer of the present invention is not limited to the illustrated embodiment in the figure, but various kinds of embodiments are available. For example, Fig. 2 shows the ink jet nozzle 15 having the pair of composite members 21 facing each other comprising the hard member 19b and the piezoelectric element 20 for adjusting the opening part. However, as shown in Fig. 3(a), another pair of composite members 21 comprising the hard member 19b and the piezoelectric element 20 for adjusting the opening part facing each other are provided so that the size of the nozzle tip opening part 15a is controlled from two directions. Since the nozzle tip opening part 15a is rectangular in both Fig. 2 and Fig. 3, it is suitable for depicting thin lines. Further, as shown in Fig. 3(b), the nozzle tip opening part 15a may be circular by disposing the composite members 21 comprising the hard member 19b and the piezoelectric element 20 for

adjusting the opening part in a throttling shape.

[0030] The ink Ia discharged from the ink jet printer 10 is not limited. Therefore, the ink jet printer can be used to form a color filter, a light absorbing layer, a phosphor layer or the like to constitute the panel inner surface of the cathode ray tube. In addition, the material to be recorded which is a printing object of the ink jet printer is not limited, and, for example, any base material impermeable against ink such as a panel of the cathode ray tube can also be a printing object.

[0031] A method for forming a fluorescent screen of the cathode ray tube of the present invention is characterized in that the intermediate film forming coating material is selectively discharged on the phosphor layer to form the intermediate film by using the ink jet printer of the present invention described above when a light absorbing layer and a phosphor layer are formed on a panel surface of the cathode ray tube, an intermediate film is formed on the phosphor layer, a metal back layer is formed on the intermediate film, and then, the intermediate film is thermally decomposed and removed to form the fluorescent screen of the cathode ray tube, and the technology other than that of forming the intermediate film may be similar to that in a conventional example.

[0032] For example, a stripe-shaped light absorbing layer

is formed on the panel inner surface by a so-called slurry method described in Japanese Patent Laid-Open No. 61-68827, and the phosphor layers of red, green and blue colors are formed between the stripe-shaped light absorbing layers. Next, by using the ink jet printer of the present invention, the intermediate film forming coating material is selectively discharged on each stripe-shaped phosphor layer to form the intermediate film.

[0033] In this case, resin emulsion or resin solution which has been used in forming the intermediate film may be used for the intermediate film forming coating material to be used. For example, a coating material of the viscosity of 430-750 cps, such as water-diffusive vinyl polymer emulsion, water-soluble emulsion of acrylic acid ester and methacrylic acid ester, lacquer solution of acrylic acid ester and methacrylic acid ester, and high boiling point aromatic solvent solution (boiling point of 190-210°C) of acrylic acid ester and methacrylic acid ester may be included.

[0034] Further, the width of the intermediate film formed by the ink jet printer is preferably and slightly smaller than the width of the phosphor layer. Holes are formed in the metal back layer of a part at which the intermediate film on the phosphor layer is not substantially coated when the intermediate film is thermally decomposed and removed through baking later, and decomposition gas of the

intermediate film can be removed from the holes, preventing the metal back layer from being raised or peeled off.

[0035] After the intermediate film forming coating material is discharged on the phosphor layer, the curing speed of the intermediate film forming coating material is increased by using a constant temperature oven as necessary, the metal back layer is formed by vapor deposition of aluminum after the intermediate film is cured, and the intermediate film is thermally decomposed and removed by baking.

[0036]

[Operation] According to the ink jet printer of the present invention, at least a part of the orifice forming member is formed of the composite members integrating the hard material with the piezoelectric element, and the opening diameter of the orifice can be easily changed and controlled to a desired size. Therefore, the opening diameter of the orifice can be changed according to the physical properties of the ink to be discharged therefrom, the particle size or the like of the pigment contained in the ink, or the like, clogging of the orifice is prevented thereby, or even when the orifice is clogged, the maintenance of the ink jet nozzle can be easily performed by largely opening the orifice. In addition, even when the orifice forming member is worn by ink, the opening diameter of the orifice can be maintained constant, and the specified recording dot

diameter can be consistently obtained. Further, when discharge of ink is stopped, the opening part of the orifice can be closed to prevent any unnecessary dripping of ink. Still further, the opening diameter of the orifice can be adjusted according to the width of the line to be depicted, and the stripes of various kinds of line widths can be efficiently depicted.

[0037] According to a method for manufacturing the fluorescent screen of the cathode ray tube, the intermediate film is formed by using the ink jet printer of the above-described invention. In this case, since the intermediate film is selectively formed on the phosphor layer, the intermediate film is not formed on the light absorbing layer even when the intermediate film is formed thick so that the metal back layer has sufficient smoothness, and the total quantity of the intermediate film is suppressed. Thus, the quantity of gases generated when the intermediate film is thermally decomposed is reduced to prevent the metal back layer from being raised or peeled off. Further, the intermediate film is selectively formed by using the ink jet printer of the present invention, and the selective formation can be performed in a considerably simplified working step compared with a case to form the intermediate film by providing the photosensitivity in the intermediate film forming coating material.

[0038]

[Embodiments] The present invention will be described below more specifically based on the embodiment.

[0039] Firstly, a stripe-shaped light absorbing layer (75 μm in width and 215 μm in pitch) formed of carbon black and red, green and blue phosphor layers (140 μm in width and 645 μm in pitch) are formed on a panel inner surface of a cathode ray tube by a slurry method.

[0040] Next, an ink jet nozzle having a hard material and a piezoelectric element is manufactured on a nozzle part of an ink jet printer manufactured by Video Jet Company, and the ink jet nozzle is fitted to a robot SRX-450 manufactured by Sony to manufacture an ink jet printer. In addition, a CCD camera is also fitted to the ink jet printer to observe a printed surface, and an image processing system SRX-VS40 manufactured by Sony is connected to the CCD camera. A robot is operated so that a tip of a nozzle travels on the position by 0.1-1.0 mm above a phosphor stripe based on the position of a light absorbing layer detected by the CCD camera, and the quantity of ink discharged from the nozzle is also controlled based on the image signals from the CCD camera.

[0041] An intermediate film is formed on the phosphor layer which is previously formed on the panel inner surface by discharging an intermediate film forming coating material by

using the ink jet printer.

[0042] Then, aluminum is vapor-deposited to the thickness of 2,800 Å at the degree of vacuum of 10^{-6} torr. to form a metal back layer, and the metal back layer is further baked (at 460°C for 2.5 hours) to decompose and remove the intermediate film.

[0043] As described above, by forming the metal back layer on the phosphor layer, the reflectance can be improved by about 50% compared with a conventional case in which the intermediate film is formed on not only the phosphor layer but also the light absorbing layer. Further, the brightness of a CRT using this panel can be improved by 30-50% compared with a conventional case.

[0044]

[Advantages] As described above, according to the ink jet printer of the present invention, the opening diameter of the orifice can be arbitrarily changed. Therefore, clogging of the ink jet nozzle can be prevented, the maintenance is facilitated, unnecessary dripping of ink can be prevented, and depiction is consistently performed with an optimum recording dot diameter.

[0045] Further, according to the method for forming the fluorescent screen of the cathode ray tube of the present invention, a step of selectively forming the intermediate film on the phosphor layer to improve the reflectance of the

metal back layer is facilitated.

[Brief Description of the Drawings]

[Fig. 1] Fig. 1 is a schematic perspective view of an ink jet recorder of the present invention.

[Fig. 2] Fig. 2 is a schematic representation of an ink jet nozzle of the present invention.

[Fig. 3] Fig. 3 is a schematic representation of another embodiment of the ink jet nozzle of the ink jet recorder of the present invention.

[Fig. 4] Fig. 4 is a schematic representation of a panel section of a cathode ray tube.

[Fig. 5] Fig. 5 is a schematic representation of a method for forming a panel inner surface of the cathode ray tube.

[Reference Numerals]

1 panel

2, 2R, 2G, 2B phosphor layer

3 light absorbing layer

4 metal back layer

5 intermediate film

10 ink jet printer

11 base table

12 robot

13 ink discharging nozzle fitting frame

14 ink discharging nozzle fitting support part

15 ink jet nozzle

15a tip opening part of ink jet nozzle

16 nozzle base body

17 piezoelectric element for manufacturing ink particles

18 high frequency power source for manufacturing ink particles

19a, 19b hard member

20 piezoelectric element for adjusting opening part

21 composite member

22 power source for adjusting opening part

23 material to be recorded

Ia ink